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The Strategy of Region Split in LRPCA

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Abstract

The Strategy of choosing local region in the facial image of LRPCA makes it perform efficiently in human face recognition. One kernel of LRPCA is the Local Region Choose. So prefer the better performs of LRPCA on human face recognition, the region choose strategy is proposed to be the key. By the discussion of the some region templates, a well strategy is given by experiments.

Keywords: LRPCA, Region Split, Face Recognition;

1. Introduction

Face Recognition in Pattern Recognition, which is the typical issue in classify of the magnitude data sets. So far, two methods are using normally in face recognition: one is based on geometrical features of human face, and another is the way based on the statistic features. In the second way, PCA/ICA and LBP are widely used for feature extracting and dimension reducing. By its well perform on dimension reduce and the feature extract on the image which is linearity, PCA (Principle Complement Analysis) becomes one of the most important way to do feature extracting in face recognition. But the whole face PCA do not gain the best recognition rate[5].

In 2010, LRPCA (Local Region PCA) was put forward with Colorado State University (U.S.A). Its difference with the traditional PCA is that, it do the feature extracting only in some given regions of a face. Its recognition rate is better than the traditional PCA.

In the paper, we force on a kernel issue of LRPCA: the region select strategy. By the comparison and analysis of experiments on the region templates, we try to give a preferred strategy of the region template select.

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3. LRPCA and Region Split

3.1. LRPCA

The traditional PCA do the feature extracting on the whole face, which will take a lot of nonsensical data as the features. While choosing some regions of a face then doing PCA, using the combined PCA features to do recognizing, the recognition rate will be improved to 98% [6]. As showing in Fig.1, the LRPCA do better than the traditional PCA on face recognition.

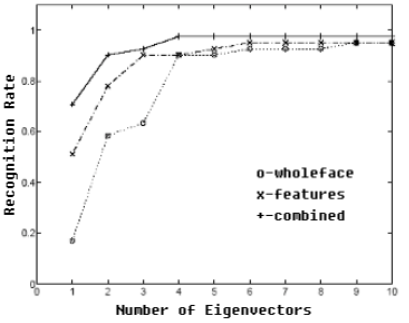

Fig. 1 recognition rate of different PCA feature extract [6]

As you can see from its name for short, LRPCA will do PCA on the local region. Training and testing images should be preprocessed. First a similarity transformation is applied which rotates, scales, and translates the faces to align the eyes. The image is then cropped tightly around the face to for a face tile. The algorithm then split the face into a small number of regions and then runs PCA on each. This provides basis vectors for each facial region. During training a weight is also learned for each eigenvector in each region. This weight determines the influence of each vector during testing and is based on the Fisher Criterion. The testing image's each region will projected onto the basis vectors which generates a set of coefficients. Each coefficient is weighted using the Fisher Criterion. The similarity of the two faces is computed using Pearson's normalized correlation which is

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{N}\right)\left(\sum Y^2 - \frac{(\sum Y)^2}{N}\right)}}.$$

3.2. Region Split in LRPCA

The segment template of face will obviously affect the recognition rate of LRPCA. The normal template is the geometrical template. Fig 2 is an example of the face region template. It is fast and easy to implement. After locate the eye, do the segment via the position of the eye. The face recognition rate is influenced by two factors: the size of image and the region template to split the face. We will discuss how many regions, and what size of each region, will be best for the LRPCA to gain the better recognition rate.

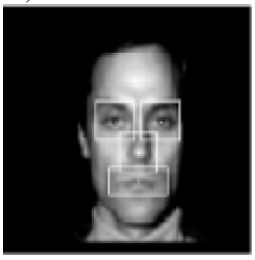

Fig. 2 Simple Region split template

4. Experiment

These experiments are designed for discussing the different template's influence on the recognition rate of LRPCA. We choose the IMM face database for test. There are 40 persons in the IMM database, each person includes six images. We choose four as training swatches and the rest two for testing on each person.

4.1. Experiment One

In this experiment，we design the five different templates to find the influence of LRPCA by region size and numbers. We define the facial region as Fig.3, and its size is 256×256.

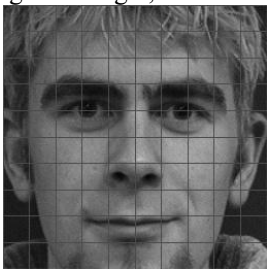

Fig. 3. face region(256×256)

Then five templates are chosen for testing. They split the face image into different regions and different sizes. The templates show in Fig.4 (a). Their splitting result shows in Fig.4 (b).

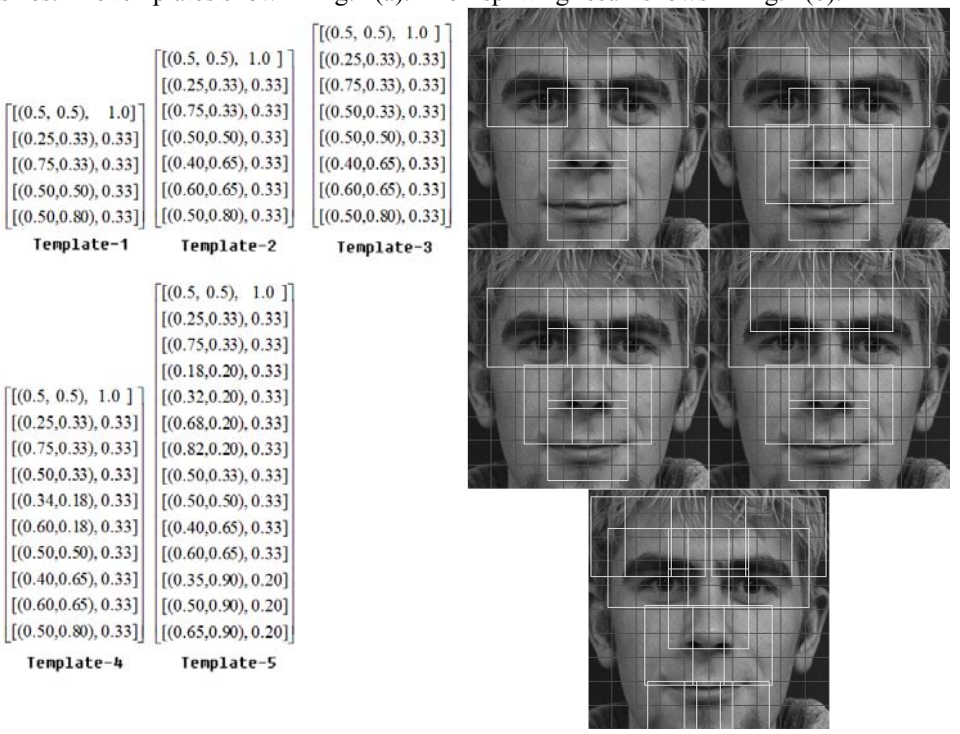

Fig. 4 (a) Region split template (b) Result of split on facial image

As you can see, these templates split the face into 4/6/7/9/14 sub regions. In the parameter of templates, the first rows is the center of the face, the other rows is the region's location and size. As showing in Table.1, we can see the recognition rate of each split template with the facial image size of 256×256, the template which split the face image into 14 sub regions (as showing in the Fig.4 template-5) do best, its recognition rate reach to 94.958% in IMM face set. And as the sub regions being more, the time cost will be increased. That is because of the increased PCA calculation for the increased sub regions and the final similarity will be more complex to calculate.

Table.1 The recognition rate of each template

Split template	Recognition rate(%)	Time cost(ms)
Template-1(4 sub regions)	80.435	127.4
Template-2(6 sub regions)	78.545	151.1
Template-3(7 sub regions	84.400.	164.7
Template-4(10 sub regions)	87.175	279.4
Template-5(14 sub regions	94.950	327.0.

*Time cost is the average of all tests that is the total time cost of 40 persons' recognition including training and recognition testing.

4.2. Experiment Two

In this experiment, we want to figure out the influence of facial image size to LRPCA, the test also base on IMM face set, we normalize the facial region into four sizes (64×64, 128×128, 256*256, 512×512) to do LRPCA with each template. Table.2 shows the result of this experiment. By analysis of Table.2, thought the template-5 with facial size 512×512 can reach a recognition rate of 95.415, but the time cost increases too much at the meantime. So in balance the facial region with size of 256×256 reaches the best performance both in recognition rate and the time cost.

Table.2 The recognition rate of experiment two

Template / Size(pixel)	Template-1	Template-2	Template-3	Template-4	Template-5
64×64	72.125/87.4	71.295/95.0	76.755/96.1	76.175/98.3	77.415/99.8
128×128	71.205/88.0	73.795/112.3	80.549/122.0	84.325/130.1	84.420/142.8
256×256	80.435/127.4	78.545/151.1	84.405/164.7	87.175/279.4	94.955/327.0
512×512	80.900/217.1	82.320/283.7	86.015/307.0	87.290/373.6	95.415/413.7

*The result with the form of xx/xx means the recognition rate/time cost.

5. Conclusion

Two keys in face recognition based on LRPCA are the split region template and the size of the facial image. After a plenty of experiments and the analysis, we found, with the geometrical template that splits the face into 14 sub regions and the face image size of 256×256, LRPCA has a best recognition rate in human face recognition.

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